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A REVISION OF THE DELTOCEPHALINE
LEAFHOPPER GENUS *GIPRUS* OMAN
(HOMOPTERA: CICADELLIDAE: DELTOCEPHALINAE)

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ABSTRACT: Members of the deltocephaline leafhopper genus *Giprus* Oman live on grasses, primarily in the desert scrub, chaparral, and marine sand dune communities of western North America. Six species are redescribed and ten new species are described. Recharacterization of the genus results in the exclusion of *Laevicephalus incongruus* Oman. Differentiation of *Giprus* species is primarily based on the male genital structures; characterization of species is through illustration, verbal description, and a diagnostic key. The fifth instar nymph is characterized. Significant infraspecific variation occurs in the size and shape of the accessory aedeagal processes of *G. siskiyou* (Oman).

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INTRODUCTION

Giprus Oman is a member of that subgroup of the Tribe Deltocephalini characterized by a linear connective and articulation between the connective and the aedeagus (Oman, 1949). Members of the genus are small to medium in size, cinereous to amber in color, and usually with fuscous markings on the wings and head. The known species inhabit western North America, occurring in climatic zones ranging from coastal to continental at latitudes from 32°N. to 47°N. and from sea level to about 2000 m. elevation. They are associated with various species of grasses, usually in chaparral, desert scrub, or sand dune communities. *Giprus* is most closely related to *Laevicephalus* DeLong but may be distinguished from it by the structure of the aedeagus.

The first known species, described by Van Duzee (1892) as *Deltocephalus cinerosus*, was subsequently placed in the subgenus *Laevicephalus* by DeLong (1926). When *Laevicephalus* was elevated to generic status in 1929 by DeLong and Sleesman, it was noted that the genus contained species with a great diversity of genitalic structures. In 1937, primarily on the basis of the male genitalia, Oman recognized and characterized a "cinerosus group" of *Laevicephalus* which included *L. cinerosus* and five additional species: *L. angelus* Oman, *L. pacificus* Oman, *L. joaquinus* Oman, *L. siskiyou* Oman, and *L. incongruus* Oman. In 1949 Oman removed the "cinerosus group" and *L. cartwrighti*, which he had described in 1932, from *Laevicephalus* and erected the genus *Giprus* to contain them.

The need for a comprehensive review of the genus became apparent when it was discovered that samples of several populations encountered in Oregon and California could not be referred to described species. The study reported here endeavors to summarize knowledge of a group that is now known to be taxonomically much more complex than was previously suspected.

MATERIALS AND METHODS

Over 3000 specimens of *Giprus*, including one holotype and 87 paratypes of seven species, were examined. Most were collected during the course of this study. Borrowed material served primarily to confirm the identity of previously described species.

Drawings were prepared with the aid of a micrometer disc ruled in 0.1 mm. squares placed in the ocular of a stereoscopic microscope, and drawing paper with a 1/2 inch square grid. Anatomical details were checked with a compound microscope at 150x. All drawings of homologous structures are to the same scale. Drawings of the internal male genitalia show a dorsal view of the connective, aedeagus, and left style; the right style is omitted. In addition, a lateral view of the aedeagus from the left side is shown.

Measurements were made with a filar micrometer. Total body length was measured as the distance from the apex of the crown to the wing tips. Median length of the head and its width immediately anterior to the eye were measured and the ratio of width (W) to length (L) computed for each individual in a sample. The mean of the W/L values for a sample (usually 10 of each species) was computed and assigned as the W/L value for the species.

Comparative morphology was used as the primary basis for classification and species discrimination; field observation of populations was used as additional evidence to supplement and reinforce conclusions.

Field collection of specimens was undertaken with four main objectives: to obtain large samples (50 or more specimens) at each collection site for the study of intra-population variation as a means of understanding infra-specific variation; to examine and compare habitats; to determine host associations; and to determine whether *G. siskiyou* is a single variable species or a group of sibling species. In order to determine whether variation in *G. siskiyou* could be considered topoclinal or ecoclinal in nature, two transects were made through the region where the species is most commonly found. The north-south transect (170 km.; 12 sites) extended between Mt. Ashland, Oregon, and 57.4 km. north of Redding, California. The east-west transect (233 km.; 14 sites) extended between Cedarville, California, and Klamath River, California.

The aedeagi of specimens from each site where *G. siskiyou* was collected were compared in a study of infra-specific variation. In order to determine the amount of variation present in any one area at a given time, individuals collected at a single site on the same day were compared.

Host associations were determined by selective sweeping of grass inflorescences.

Holotypes of new species will be deposited in the United States National Museum of Natural History (NMNH) except for that of *Giprus decurvatus* which is deposited in the California Academy of Sciences. Paratypes of all new species

described in this paper, except *G. vastitatus*, were collected at the same locality as the holotype.

CHARACTERIZATION OF THE GENUS AND SPECIES GROUPS

Head approximately twice as long medially as the shortest distance between the eyes, giving the head a rather pointed appearance which is accentuated by oblique fuscous dashes on each anterolateral submargin of the crown (fig. 5). Pronotum brown with parallel rows of longitudinal pale stripes. Clypeus usually dark colored with horizontal rows of thin pale lines and a pale median line. Ratio of the head width immediately anterior to the eyes to the median length of the head between 1.20:1 and 1.30:1 in most species.

Significant forewing characters are the small appendix, inner anteapical cell almost always closed basally, and the central anteapical cell usually constricted (fig. 3). Forewings transparent with ground color cinereous to amber in all species except *G. cartwrighti* which has a greenish-gold ground color. In most species at least some individuals have fuscous markings concentrated around the periphery of the wing cells.

Most specimens are between 3.50 mm. and 4.50 mm. long. Males tend to be slightly smaller than females although frequently the smallest female in a sample may be smaller than the largest male.

Important characters of the genitalia include heavily setose pygofer in both sexes, broad male plates, large triangular valve, aedeagus with a basal submembranous hood-like extension for attachment to the tenth segment, and aedeagal shaft arising from a point dorsad of the point of articulation of the phallobase and the connective (fig. 14). The latter condition is the main difference between *Giprus* and its nearest relative, *Laevicephalus*, as the articulation of the connective and the phallobase in *Laevicephalus* is directly in line with the aedeagal shaft (fig. 15). Length, curvature, and thickness of the aedeagal shaft, and position and number of paired aedeagal processes show considerable diversity among members of the genus, and therefore species may be grouped by these characteristics (fig. 1). Group I includes only *G. cartwrighti*, placed alone because of its elongate, sinuate aedeagus unlike any other in *Giprus*; Group II includes those with a long slender aedeagus with short apical processes; Group III includes those with a short stout aedeagus which is enlarged apically; and Group IV includes those with a pair of elongate processes at some point on the aedeagus. Genital plates of males of *Giprus*, except for those of *G. cartwrighti* which are elongate and gradually tapering (fig. 13), may be similar for several species with markedly different internal structures. Three types of plates are present: plates entirely contiguous with apices acute (fig. 10); plates broadly rounded, basally contiguous but diverging posteriorly and abruptly narrowing in some to acute apices (fig. 11); or an intermediate condition with plates

divergent posteriorly and gradually tapering to acute apices (fig. 12). Groupings according to plate type do not coincide with groupings by aedeagal structure.

The posterior margin of the seventh sternum of the female is characterized by two pairs of median dentate projections (figs. 6, 7, 8). The dorsal extension of the seventh sternum mentioned by Readio (1922) in connection with his work on the ovipositors of leafhoppers, is readily visible in cleared specimens of *Giprus* and appears as either a single sclerotized structure in some species (figs. 7, 8) or as a pair of sclerotized lobes connected by a membrane in others (fig. 6). The dorsal extension arises from the seventh sternum posteromedially between the outer pair of dentate projections. The posterior portion of the ventral part of the seventh sternum is unpigmented; the heavily sclerotized dorsal extension gives the posterior margin of the seventh sternum its characteristic color pattern.

Bluntness or pointedness of the head varies among the species. Mean W/L values range from 1.20, indicating a very pointed head, to 1.46, indicating a very blunt head. It is notable that the species with blunt heads all occupy coastal habitats, but head shape, while perhaps useful as an indicator of habitat, is not a reliable character for species discrimination because there is too much overlap of values between the species (fig. 2).

Fifth instar nymphs of *Giprus* are cream colored with extensive light brown to fuscous markings on the head, pronotum, wing pads, and abdominal dorsum (fig. 4). The abdominal venter has fewer dark markings. The eyes, head, and body of nymphs frequently have a reddish cast.

Laevicephalus incongruus, placed in *Giprus* by Oman (1949), is atypical of *Giprus* in several characteristics. It is conspicuously larger than other members of the genus; the posterior margin of the seventh sternum of the female is emarginate; and most significantly, the structure of the aedeagus is unlike that of typical *Giprus* species. The aedeagus of *L. incongruus* is more like that of *Laevicephalus* than that of *Giprus* in that the point of articulation of the connective and the phallobase is directly opposite the shaft of the aedeagus (fig. 16). For these reasons, I remove *L. incongruus* from *Giprus* and return it to *Laevicephalus*. On the basis of the structure of the aedeagus, it would appear that *L. incongruus* would fit most closely into the "parvulus subgroup" as characterized by Ross and Hamilton (1972).

Several characteristics of *G. cartwrighti* suggest that it is not closely related to other species in the genus. The almost semicircular seventh sternum of the female, the elongate, tapered genital plates of the male, and the sinuate aedeagus are reminiscent of *Laevicephalus*. However, the position of the aedeagal shaft relative to the connective places the species in *Giprus*. Structurally, *G. cartwrighti* seems to be intermediate between the two genera, and it is of interest that the only instances where two species of *Giprus* occur together are those where *G. cartwrighti* is one of the sympatric pair. This suggests that

G. cartwrighti and other *Giprus* species do not compete ecologically to such an extent as to allow only one species to exist at a given locality. Also, *G. cartwrighti* is most frequently encountered in open grassland habitats such as those favored by species of *Laevicephalus*.

KEY TO THE SPECIES OF GIPRUS

- 1 Aedeagus approximately 3 times the length of the connective, slender, and sinuate, with minute apical processes (fig. 36); male genital plates attenuate with diverging apices (fig. 13); 7th sternum of female nearly semicircular with small median incision (fig. 9) *G. cartwrighti*
- 1' Aedeagus no more than 2 times the length of the connective; male plates short and stout; 7th sternum of female incised posterolaterally (figs. 6, 7, 8) 2
- 2(1') Aedeagus with at least one pair of elongate retrorse processes that diverge obliquely from the longitudinal axis of the shaft; if the longest pair of processes is less than 1/3 the length of the aedeagal shaft, then they originate considerably basad of the apex 3
- 2' Aedeagus without elongate retrorse processes; aedeagal armature consisting of stout retrorse dentate processes, lateral flanges, or slightly elongate processes that originate near the apex 8
- 3(2) Aedeagus with one pair of straight or sinuate lateral or lateroventral elongate processes arising at or near the apex and no more than one other pair of processes 4
- 3' Aedeagus with 3 pairs of processes, or if only 2, then the slightly elongate pair originates considerably basad of the apex 5
- 4(3) Aedeagus with a single pair of elongate, sinuate, lateroventral apical processes about 3/4 the length of the aedeagal shaft; no ventral processes (fig. 29) *G. vastitatus*
- 4' Two pairs of aedeagal processes: short ventral processes originating at the base of the elongate lateral processes and curving mesad (figs. 30, 31); lateral processes either straight or sinuate in lateral view *G. californicus*

5(3')	Aedeagus with 3 pairs of processes: one pair short and ventral, one pair elongate and lateral, and one pair very short and dorsal	6
5'	Aedeagus with fewer than 3 pairs of processes	7
6(5)	All pairs of processes apparently originating at the same point on the aedeagal shaft; ventral processes not visible in dorsal view (fig. 35)... <i>G. cinerosus</i>	
6'	Elongate processes clearly originating basad of the other processes; ventral processes extending slightly laterad and therefore visible in dorsal view (fig. 34)	<i>G. desertorum</i>
7(5')	Aedeagus with dorsal and lateral processes only; shaft stout and straight (fig. 33)	<i>G. cajon</i>
7'	Aedeagus with lateral and lateroventral processes only; shaft somewhat sinuate (fig. 32)	<i>G. pacificus</i>
8(2')	Aedeagus with a single pair of lateroventral processes	9
8'	Aedeagus with more than one pair of processes or processes not as above	10
9(8)	Aedeagal shaft slender, slightly decurved, and with acute apex in dorsal view; processes pointing posteriorly in lateral view (fig. 22)	<i>G. arenarius</i>
9'	Aedeagal shaft not overly slender; processes pointing anteriorly in lateral view (fig. 21)	<i>G. bidentatus</i>
10(8')	Aedeagus with a single pair of dorsal processes combined with a pair of more or less well developed (and at times asymmetrical) lateral flanges (figs. 17-20)	<i>G. siskiyou</i>
10'	Aedeagus with more than one pair of processes; no lateral flanges	11
11(10')	Aedeagus with 2 pairs of processes	12
11'	Aedeagus with 3 pairs of processes	14
12(11')	Aedeagal shaft strongly decurved with dorsal and lateral processes well developed; shaft fairly robust (fig. 24)	<i>G. decurvatus</i>
12'	Aedeagal shaft not strongly decurved; if slightly decurved then the processes very small	13

- 13(12') Aedeagus with dorsolateral and ventro-lateral processes very small (fig. 23); female 7th sternum much longer medially than laterally (fig. 8) *G. joaquinus*
- 13' Aedeagus with dorsal and lateroventral processes well developed (fig. 25)...*G. angelus*
- 14(11') Aedeagus with a pair of short, thin, lateral processes arising distinctly basad of the bulbous apex (fig. 27)..*G. orarius*
- 14' Aedeagus without lateral processes as above 15
- 15(14') In dorsal view aedeagus 4 times as long as greatest width of apical processes; in lateral view apical processes oriented obliquely to the longitudinal axis of the aedeagal shaft (fig. 28)..... *G. agrestis*
- 15' In dorsal view aedeagus twice as long as the greatest width of the apical processes; in lateral view apical processes essentially transverse to the longitudinal axis of the aedeagal shaft (fig. 26) *G. crassus*

DESCRIPTIONS OF SPECIES

Giprus cartwrighti (Oman).

Laevicephalus cartwrighti Oman 1932, p. 90.

LENGTH. Female: 4.01 mm. - 4.54 mm.; male: 3.87 mm. - 4.19 mm.

COLOR. Pale, pattern indistinct, ground color greenish gold.

HEAD SHAPE. W/L = 1.20.

FEMALE 7TH STERNUM. Dorsal extensions separate and posterior margin semicircular; dentate projections on posterior margin equal in length and projecting only slightly (fig. 13).

MALE GENITALIA. Plates elongate and gradually tapering to acute diverging apices. Aedeagus whiplike, sinuate, and with minute apical processes. Styles flared near tip (fig. 36).

HOLOTYPE. Male, Sloughhouse, California, 19 May 1931, Cartwright.

DISTRIBUTION. CALIFORNIA: Butte County: Oroville; Fresno County: Coalinga; Kern County: Tehachapi Pass; Monterey County: Bryson; San Bernardino County: 3.2 km. S. Rock Camp, Lake Arrowhead; San Joaquin County: Lockeford; Santa Clara County: Los Gatos Canyon; Siskiyou County: 25.7 km. E. Klamath River, 18.5 km. N. Weed, 25.1 km. N. Yreka, 0.8 km. E. Yreka. OREGON: Jackson County: 5.1 km.

S. Ruch, Agate Desert, Agate Lake, Upper Table Rock N. of Medford; Josephine County: 8 km. SW. Cave Junction (April - December).

HABITAT AND HOSTS. Usually collected in mixed grass-land, host unknown.

Giprus siskiyou (Oman).

Laevicephalus siskiyou Oman 1937, p. 478.

LENGTH. Female: 3.76 mm. - 4.58 mm.; male: 3.50 mm. - 4.32 mm.

COLOR. Dark, pattern distinct.

HEAD SHAPE. W/L = 1.27.

FEMALE 7TH STERNUM. Dorsal extensions separate; inner pair of dentate projections on the posterior margin shorter than outer pair.

MALE GENITALIA. Genital plates entirely contiguous with acute apices (fig. 10). Aedeagus with one pair of dorsal processes near apex. Lateral flanges basad of processes very variable, may be more or less well developed, and are often asymmetrical. Style tips small and blunt. Aedeagal apex notched in lateral view (figs. 17-20 & 37-72).

HOLOTYPE. Male, Mt. Shasta, California, 29 June 1935, Oman.

DISTRIBUTION. CALIFORNIA: Modoc County: 24.1 km. NE. Alturas, 11.3 km. NE. Alturas, Fandango Pass 1829 m.; Shasta County: 20.9 km. S. Castella, 3.2 km. S. Castella; Siskiyou County: Bray, 26.1 km. N. Yreka, 21.6 km. N. Yreka, 0.8 km. E. Yreka, 25.7 km. E. Klamath River, 18.5 km. N. Weed, N. of Weed, 4.8 km. S. Weed, Mt. Shasta City, S. of Mt. Shasta City, 24 km. SE. Mt. Shasta, Dunsmuir. IDAHO: Bonneville County: 7 km. SE. Irwin. NEVADA: Ormsby County: Carson City. OREGON: Jackson County: Mt. Ashland 1402 m. and 1250 m., Siskiyou Summit, Pinehurst; Klamath County: 30.6 km. W. Klamath Falls, Klamath Falls, 35.4 km. E. Klamath Falls, 48.3 km. E. Klamath Falls, 57.9 km. E. Klamath Falls, 9.6 km. E. Bly; Harney County: 17.7 km. E. Frenchglen. WASHINGTON: Kittitas County: Cliffdell; Pierce County: Mt. Rainier (Cottonwood Flats); Yakima County: Naches, 40.2 km. S. Toppenish, 57.9 km. S. Toppenish (May - July).

HABITAT AND HOSTS. Chaparral and desert scrub on *Stipa lemmonii*, *Poa* species, *Bromus* species (one locality), *Sitanion jubatum* (one locality).

Giprus arenarius Sawbridge, new species.

LENGTH. Female: 3.68 mm. - 3.96 mm.; male: 3.30 mm. - 3.86 mm.

COLOR. Very pale, little pigment deposited around periphery of wing cells.

HEAD SHAPE. W/L = 1.43.

FEMALE 7TH STERNUM. Dorsal extensions separate; both pairs of dentate projections on posterior margin of equal

length.

MALE GENITALIA. Genital plates divergent posteriorly and gradually tapering to acute apices (fig. 12). Aedeagal shaft slightly decurved and supporting a single pair of lateroventrally projecting processes. Apex of aedeagus acute. Styles broad at tips (fig. 22).

HOLOTYPE. Male, 4.0 km. N. Waldport, Oregon, 3 July 1970, Oman.

PARATYPES. 21 females, 22 males, 3 July 1970, Oman; 13 females, 15 males, 1 July 1971, Sawbridge.

DISTRIBUTION. OREGON: Coos County: 8 km. S. Bandon; Curry County: 9.6 km. S. Brookings, 12.8 km. N. Gold Beach; Lane County: 13.7 km. N. Florence; Lincoln County: 4.0 km. N. Waldport (June - September).

HABITAT AND HOSTS: *Poa macrantha* and *Festuca rubra* on sand dunes.

Giprus bidentatus Sawbridge, new species.

LENGTH. Female: 4.26 mm. - 4.49 mm.; male: 4.12 mm.

COLOR. Medium brown.

HEAD SHAPE. W/L = 1.27.

FEMALE 7TH STERNUM. Dorsal extensions separate; inner and outer pairs of dentate projections on posterior margin of equal length.

MALE GENITALIA. Genital plates as in *G. arenarius*. Aedeagus with one pair of short, lateroventrally projecting apical processes which point anteriorly in lateral view (fig. 21). Style tips slender and elongate.

HOLOTYPE. Male, 8 km. SW. Cave Junction, Oregon, 15 June 1972, Oman.

PARATYPES. 11 females, 6 males, 15 June 1972, Oman; 1 female, 3 males, 13 May 1972, Sawbridge.

DISTRIBUTION. CALIFORNIA: Del Norte County: 3.2 km. E. Gasquet. OREGON: Josephine County: 8 km. SW. Cave Junction (May - July).

HABITAT AND HOST. In chaparral, host unknown.

Giprus joaquinus (Oman).

Laevicephalus joaquinus Oman 1937, p. 478.

LENGTH. Female: 4.12 mm.; male: 3.95 mm.

COLOR. Light brown.

HEAD SHAPE. W/L = 1.23.

FEMALE 7TH STERNUM. Elongate medially, about three times the length at the lateral margin. Dorsal extensions fused (fig. 8).

MALE GENITALIA. Genital plates as in *G. siskiyou*. Aedeagus long and slightly decurved with two pairs of small apical processes, one pair dorsal and the other ventral. Style tips broad and flat (fig. 23).

HOLOTYPE. Male, Califa, California, 12 June 1935, Oman.

DISTRIBUTION. CALIFORNIA: Madera County: Califa (June).

HABITAT AND HOST. Unknown.

Giprus decurvatus Sawbridge, new species.

LENGTH. Female: 4.82 mm.; male: 4.08 mm. - 4.36 mm.

COLOR. Light brown.

HEAD SHAPE. W/L = 1.25.

FEMALE 7TH STERNUM. No record; only female has abdomen missing.

MALE GENITALIA. Genital plates as in *G. desertorum* new species. Aedeagus strongly decurved with two pairs of short, narrow, apical processes, one pair originating dorsally and the other laterally. Styles with blunt tips (fig. 24).

HOLOTYPE. Male, Grass Valley, California, 18 May 1930, Van Duzee.

PARATYPES. 1 female, 1 male, 18 May 1930, Van Duzee.

DISTRIBUTION. CALIFORNIA: Nevada County: Grass Valley; Placer County: Dutch Flat (May - June).

HABITAT AND HOST. Unknown.

Giprus angelus (Oman).

Laevicephalus angelus Oman 1937, p. 478.

LENGTH. Female: 3.59 mm. - 4.04 mm.; male: 3.79 mm. - 4.05 mm.

COLOR. Light brown.

HEAD SHAPE. W/L = 1.26.

FEMALE 7TH STERNUM. Dorsal extension fused; inner pair of dentate projections on posterior margin shorter than outer pair.

MALE GENITALIA. Genital plates as in *G. siskiyou*. Aedeagus with two pairs of apical processes, one pair dorsal and the other pair lateroventral. Style tips blunt (fig. 25).

HOLOTYPE. Male, above Mint Canyon, California, 8 June 1935, Oman.

DISTRIBUTION. CALIFORNIA: Los Angeles County: Mint Canyon; Monterey County: Salinas (June).

HABITAT AND HOST. Unknown.

Giprus crassus Sawbridge, new species.

LENGTH. Female: 4.00 mm. - 4.23 mm.; male: 3.77 mm. - 4.07 mm.

COLOR. Medium brown.

HEAD SHAPE. W/L = 1.23.

FEMALE 7TH STERNUM. Dorsal extension fused; inner pair of dentate projections on posterior margin much shorter than outer pair.

MALE GENITALIA. Genital plates as in *G. desertorum* except apices are subacute. Aedeagus short, stout, broadest at apex, and with three pairs of short apical processes: one pair lateroventral, one pair lateral, and one pair

dorsal. Styles short and broad with blunt tips (fig. 26).

HOLOTYPE. Male, Sams Valley, Oregon, 15 May 1970, Oman.

PARATYPES. 14 females, 16 males, 15 May 1970, Oman;
3 females, 12 males, 29 May 1971, Oman.

DISTRIBUTION. OREGON: Jackson County: Sams Valley
(May - June).

HABITAT AND HOSTS. In chaparral on *Stipa lemmonii*, *Poa scabrella*.

Giprus orarius Sawbridge, new species.

LENGTH. Female: 3.66 mm. - 3.96 mm.; male: 3.84 mm. - 3.96 mm.

COLOR. Very pale, little pigment deposited around periphery of wing cells.

HEAD SHAPE. W/L = 1.46.

FEMALE 7TH STERNUM. Dorsal extensions separate; inner pair of dentate projections on posterior margin shorter than outer pair.

MALE GENITALIA. Genital plates as in *G. siskiyou*. Aedeagus with a bulbous apex produced into a pair of lateroventral processes. A pair of thin laterodorsally projecting processes originate basad of the bulbous apex. Style tips broad (fig. 27).

HOLOTYPE. Male, 16.1 km. (10 mi.) N. Pacific City, Oregon, 20 July 1971, Sawbridge.

PARATYPES. 18 females, 13 males, 20 July 1971, Sawbridge; 47 females, 22 males, 20 July 1971, Viraktamath.

DISTRIBUTION. OREGON: Coos County: 17.7 km. S. Reedsport; Douglas County: 17.7 km. S. Florence; Lincoln County: 1.6 km. S. Newport; Tillamook County: Nehalem Bay State Park, 16.1 km. N. Pacific City, 1.6 km. N. Pacific City (July - August).

HABITAT AND HOSTS. On sand dunes on *Poa macrantha* and *Festuca rubra*.

Giprus agrestis Sawbridge, new species.

LENGTH. Female: 3.91 mm. - 4.41 mm.; male: 3.71 mm. - 4.07 mm.

COLOR. Dark brown.

HEAD SHAPE. W/L = 1.20.

FEMALE 7TH STERNUM. Dorsal extension fused; inner pair of dentate projections on posterior margin almost as long as outer pair (fig. 7).

MALE GENITALIA. Genital plates as in *G. siskiyou*. Aedeagus short with three pairs of apical processes: one pair dorsal, one pair lateral, and one pair ventral. Aedeagus broadly rounded apically. Styles with small flared tips (fig. 28).

HOLOTYPE. Male, Merlin, Oregon, 27 May 1970, Oman.

PARATYPES. 16 females, 15 males, 27 May 1970, Oman;
13 females, 10 males, 13 May 1972, Sawbridge.

DISTRIBUTION. OREGON: Josephine County: Merlin (May - June).

HABITAT AND HOST. In chaparral on *Danthonia californica* var. *americana*.

Giprus cinerosus (Van Duzee).

Deltocephalus cinerosus Van Duzee 1892, p. 305.

Laeviocephalus cinerosus (Van Duzee); DeLong and Slesman 1929, p. 93.

Giprus cinerosus Oman 1949, p. 164.

LENGTH. Female: 4.30 mm. - 4.31 mm.; male: 3.91 mm. - 4.17 mm.

COLOR. Light brown.

HEAD SHAPE. W/L = 1.27.

FEMALE 7TH STERNUM. Lateral margins short; dorsal extensions separate; inner pair of dentate projections on posterior margin slightly shorter than outer pair.

MALE GENITALIA. Genital plates as in *G. desertorum*. Aedeagus with three pairs of apical processes all originating at the same point on the shaft: a short ventral pair, an elongate lateral pair, and a short dorsal pair (fig. 35). Style tips broad.

LECTOTYPE. Male, California, Coquillett.

DISTRIBUTION. CALIFORNIA: Los Angeles County; Orange County: Newport Beach; Riverside County: Perris; San Diego County: El Cajon, Pala, Witch Creek (February - May).

HABITAT AND HOST. Unknown.

Giprus desertorum Sawbridge, new species.

LENGTH. Female: 3.59 mm. - 3.88 mm.; male: 3.29 mm. - 3.50 mm.

COLOR. Light brown.

HEAD SHAPE. W/L = 1.28.

FEMALE 7TH STERNUM. Dorsal extensions separate; inner pair of dentate projections on the posterior margin longer than outer pair.

MALE GENITALIA. Genital plates broadly rounded, anteriorly contiguous, but diverging posteriorly and abruptly narrowing to acute apices (fig. 11). Aedeagus with three pairs of processes: a short ventral pair, an elongate lateral pair arising basad of the ventral pair, and a very short dorsal pair. Style tips broad (fig. 34).

HOLOTYPE. Male, 4.8 km. (3 mi.) N. Rosamond, California, 23 March 1971, Sawbridge.

PARATYPES. 10 females, 20 males, 23 March 1971, Sawbridge; 8 females, 14 males, 23 March 1971, Oman.

DISTRIBUTION. CALIFORNIA: Los Angeles County: 4.8 km. S. Lancaster, 4.8 km. N. Rosamond (March - April).

HABITAT AND HOSTS. Amongst desert scrub on *Stipa speciosa* and *Oryzopsis* species.

Giprus californicus Sawbridge, new species.

LENGTH. Female: 3.95 mm. - 4.21 mm.; male: 3.65 mm. - 4.20 mm.

COLOR. Medium brown.

HEAD SHAPE. W/L = 1.28.

FEMALE 7TH STERNUM. Dorsal extensions separate; dentate projections on posterior margin of equal length.

MALE GENITALIA. Genital plates as in *G. siskiyou*. Aedeagus with a pair of straight or sinuate laterally projecting processes from which arise a pair of ventral processes which curve toward the midline (figs. 30, 31). Curvature of lateral processes varies between populations.

HOLOTYPE. Male, 43.5 km. (27 mi.) SE. Bakersfield, California, 23 March 1971, Sawbridge.

PARATYPES. 9 females, 12 males, 23 March 1971, Sawbridge; 5 females, 5 males, 22 April 1971, Oman.

DISTRIBUTION. CALIFORNIA: Kern County: 43.5 km. SE. Bakersfield, Tehachapi Pass 579 m. and 823 m.; Marin County: Mill Valley; Napa County: 3.2 km. N. St. Helena, Bothe-Napa State Park, 4.2 km. W. Oakville; Santa Cruz County: Highland District (March - June).

HABITAT AND HOST. In chaparral, host unknown.

Giprus vastitatus Sawbridge, new species.

LENGTH. Female: 3.73 mm. - 4.12 mm.; male: 3.51 mm. - 4.13 mm.

COLOR. Medium brown.

HEAD SHAPE. W/L = 1.29.

FEMALE 7TH STERNUM. Dorsal extensions separate; inner pair of dentate projections on posterior margin shorter than outer pair.

MALE GENITALIA. Genital plates as in *G. siskiyou*. Aedeagus short and slightly sinuate with one pair of sinuate processes originating lateroventrally and extending basally approximately 3/4 the length of the aedeagal shaft (fig. 29).

HOLOTYPE. Male, 16 km. (10 mi.) N. Winnemucca, Nevada, 23 June 1971, Sawbridge.

PARATYPES. 2 females, 1 male, 6.4 km. (4 mi.) NW. Winnemucca, Nevada, 23 June 1971, Oman.

DISTRIBUTION. NEVADA: Humboldt County: Winnemucca, 6.4 km. NW. Winnemucca, 16 km. N. Winnemucca. UTAH: Washington County: St. George. March (Utah) - June (Nevada).

HABITAT AND HOST. In desert scrub, host unknown.

Giprus cajon Sawbridge, new species.

LENGTH. Female: 3.79 mm. - 4.03 mm.; male: 3.53 mm. - 3.93 mm.

COLOR. Medium brown.

HEAD SHAPE. W/L = 1.26.

FEMALE 7TH STERNUM. Dorsal extensions separate; inner pair of dentate projections on posterior margin shorter than outer pair.

MALE GENITALIA. Genital plates as in *G. desertorum*. Aedeagus with somewhat elongate dorsal processes arising

more than 1/3 of the distance from the apex to the base and with lateroventral processes arising near the apex. Aedeagal shaft somewhat stout. Style tips broad (fig. 33). Considerable variation.

HOLOTYPE. Male, 1.6 km. (1 mi.) NW. top of Cajon Pass, California, 23 April 1971, Oman.

PARATYPES. 11 females, 5 males, 23 April 1971, Oman.

DISTRIBUTION. CALIFORNIA: San Bernardino County: 1.6 km. NW. top of Cajon Pass (April).

HABITAT AND HOST. In chaparral on *Stipa speciosa*.

Giprus pacificus (Oman).

Laevicephalus pacificus Oman 1937, p. 477.

LENGTH. Female: 3.23 mm. - 3.26 mm.; male: 2.81 mm. - 3.01 mm.

COLOR. Pale to light brown.

HEAD SHAPE. W/L = 1.33.

FEMALE 7TH STERNUM. Dorsal extensions separate; inner pair of dentate projections on posterior margin as long as outer pair; median incision short.

MALE GENITALIA. Genital plates as in *G. siskiyou*. Aedeagus sinuate with two pairs of processes: a somewhat elongate lateral pair arising at a point about 1/3 of the distance from the apex of the aedeagus to the base and a short ventral pair arising near the apex. Style tips broad (fig. 32).

HOLOTYPE. Male, Montara, California, 13 June 1935, Oman.

DISTRIBUTION. CALIFORNIA: Alameda County: Bay Farm; San Mateo County: Montara, Pillar Point, (?) Half Moon Bay (May - July).

HABITAT AND HOST. On coastal bluffs, host unknown.

INFRASPECIFIC VARIATION

Intraspecific variation in *Giprus* is evident in the overall size, pattern and degree of pigmentation of the head and wings, shape and pigmentation of the female seventh sternum, wing venation, and structure of the aedeagus. The latter is the most taxonomically significant type of variation as species can be readily distinguished only on the basis of aedeagal structure. Aedeagal variation is evident in five species: *G. cajon*, *G. pacificus*, *G. californicus*, *G. vastitatus*, and *G. siskiyou*.

The most obvious and frequently encountered infraspecific variation is found in *G. siskiyou*. While the dorsal processes and apical notch are more or less constant in shape and size, noticeable variation occurs in the degree of development of the lateral flanges. In the original description of the species Oman (1937) made no reference to the presence of lateral flanges, and the individual illustrated in his paper was probably an extreme

case showing little or no flange development.

While most specimens from northern California and southern Oregon and the single specimen from Carson City, Nevada, have an aedeagus with moderately developed lateral flanges (fig. 17), specimens from localities in Washington, northeastern California, and Steens Mountain, Oregon, show much greater development of the lateral flanges (figs. 18-20).

Two samples of populations, one from south of Weed, California, in the north-south transect and the other from 58 km. east of Klamath Falls, Oregon, in the east-west transect were chosen for dissection to determine the extent of aedeagal variation present at any one time in the core area of *G. siskiyou* distribution. Flange development in these samples ranges from slight lateral protrusions which merely suggest the presence of flanges (figs. 52, 53, 72) to well developed structures (figs. 37, 54, 55). Figure 54 illustrates extreme development of the lateral flanges. The lateral flanges exhibit greater asymmetry than is usually found among aedeagal structures of *Giprus*, an extreme condition being that illustrated in figure 49. Variation also occurs in the position of the lateral flanges on the shaft relative to the dorsal processes. Figures 37, 38, and 47 show specimens which have the lateral flanges projecting only slightly basad of the dorsal processes while figures 39 and 55 show individuals with lateral flanges extended considerably basad of the dorsal processes.

The variation shown in these samples is highly significant because it indicates that structures such as those seen in specimens from southcentral Washington, Steens Mountain, Oregon, and northeastern California fall within the demonstrable range of variation of *G. siskiyou*. A single specimen (fig. 54) from 58 km. east of Klamath Falls, Oregon, shows greater development of the lateral flanges than is shown in any of the individuals from isolated or peripheral areas.

Although the aedeagal structure of only five *G. cajon* specimens was examined, considerable infraspecific variation was noted. One specimen had two very small dorsal processes originating at the bases of the dorsal elongate processes. Another was markedly asymmetrical with the processes on the right arising from the aedeagal shaft basad of those on the left. The angle between the elongate dorsal processes and the shaft is also variable. Variation in the angle formed by the lateral processes and the aedeagal shaft occurs in *G. pacificus*.

Structural variation between populations of the same species also occurs. Specimens of *G. californicus* from Tehachapi Pass (fig. 30), Napa Valley, and the Highland District of Santa Cruz County, California, have straight elongate processes and ventral processes with acute apices. Specimens of *G. californicus* from Mill Valley, California, (fig. 31) have distinctly sinuate elongate processes and ventral processes with acute apices. Minor differences also occur between specimens of *G. vastitatus* collected in

southern Utah and northern Nevada. Specimens from intervening localities may show such differences to be part of the normal range of variation in this species.

HABITAT

Species of *Giprus* have been found in five types of habitats: chaparral, desert scrub, marine sand dunes, coastal bluffs, and grassland. While all the members of the genus are found on grasses, *Giprus* does not exhibit any obvious host specificity within that plant group. Grasses from which *Giprus* species have been taken are not confined to any group of grasses recognized in Gould's (1968) classification of genera. In several instances a species of *Giprus* has been collected from more than one genus of grass and a single species of grass has been observed to host more than one species of *Giprus*, although only at different localities.

Chaparral habitats (Cooper, 1922; Detling, 1961) are occupied by *G. bidentatus*, *G. crassus*, *G. agrestis*, *G. californicus*, *G. siskiyou*, and *G. cajon*. All but the latter inhabit the type of chaparral described by Detling (1961) as northern California - southern Oregon chaparral, dominated by *Ceanothus cuneatus*. Other common plants include *Arctostaphylos viscida*, *A. canescens*, *Quercus* species, *Arbutus menziesii*, and *Purshia tridentata*. Grass hosts determined included *Stipa lemmonii*, *Poa scabrella*, and *Danthonia californica* var. *americana*. *Giprus cajon* occurs in a southern California chaparral at the transition between *Yucca brevifolia* and *Juniperus* species zones. Specimens were collected from *Stipa speciosa* amongst *Eriogonum fasciculatum* and *Salvia dorii* subspecies *carnea*.

Desert scrub habitats are occupied by *G. siskiyou*, *G. desertorum*, and *G. vastitatus*. East of the Cascade Range *G. siskiyou* inhabits an *Artemisia tridentata* dominated shrub-steppe as described by Franklin and Dyrness (1969) and is found on *Stipa lemmonii* and *Poa* species. *Giprus vastitatus* is found in the even drier sagebrush - grass zone of the Great Basin described by Billings (1951). *Giprus desertorum* lives on *Stipa speciosa* and *Oryzopsis* species in the Mojave Desert amongst *Yucca brevifolia*, *Grayia spinosa*, *Atriplex* species, *Tetradymia canescens*, *Coreopsis* species, and *Larrea divaricata*.

Giprus arenarius and *G. orarius* are found on both *Festuca rubra* and *Poa macrantha* on the sand dunes of the Oregon Coast. The part of the dunes on which these grasses and leafhoppers occur is still very unstable with few if any shrubs present. Other plants which may occur along with the host grasses are *Lathyrus* species, *Tanacetum camphoratum*, *Lupinus* species, and *Glehnia leiocarpa*. *Giprus arenarius* and *G. orarius* are almost always found on the lee side of foredunes or on the slopes of higher dunes farther inland; they have never been found sympatrically.

Giprus pacificus has been collected from bluffs at Pillar Point, California, a habitat with considerably more vegetation than the Oregon dunes. However, female specimens which may also be *G. pacificus* were taken from grasses on unstable dunes about a mile south of the bluff site.

Giprus cartwrighti is typically found in flat, shrubless, open areas with mixed short grasses and forbs. Occasionally it is found in the chaparral association.

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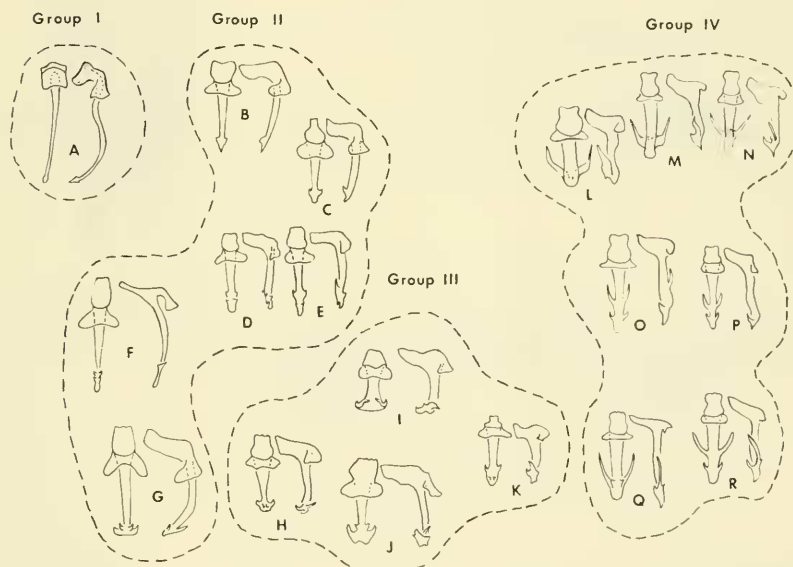


FIGURE 1. Species groups of *Giprus* based on the structure of the aedeagus. Group I: A, *G. cartwrighti*. Group II: B, *G. arenarius*, C, *G. bidentatus*, D, *G. siskiyou*, E, *G. siskiyou*, F, *G. joaquinus*, G, *G. decurvatus*. Group III: H, *G. angelus*, I, *G. crassus*, J, *G. orarius*, K, *G. agrestis*. Group IV: L, *G. vastitatus*, M, *G. californicus*, N, *G. californicus*, O, *G. cajon*, P, *G. pacificus*, Q, *G. cinerosus*, R, *G. desertorum*.

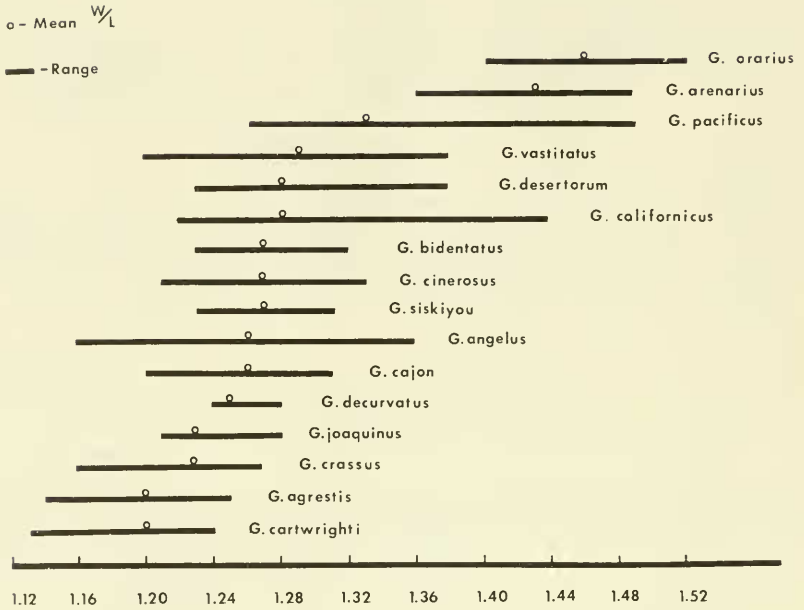
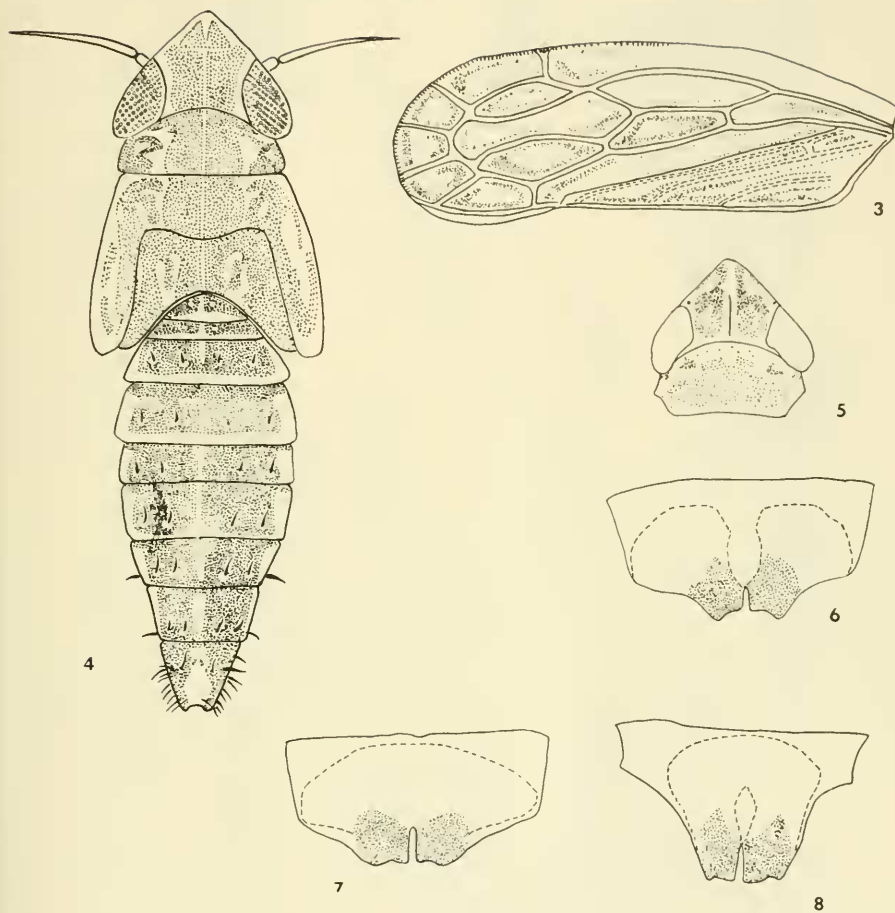
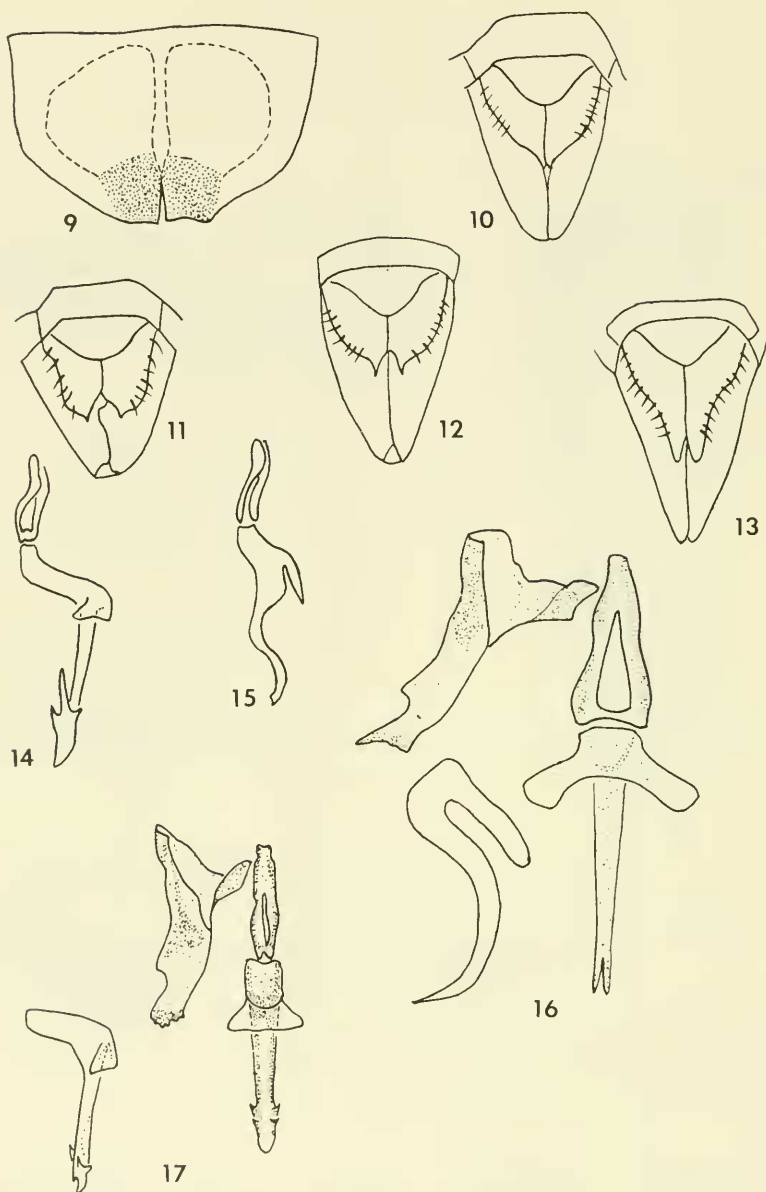


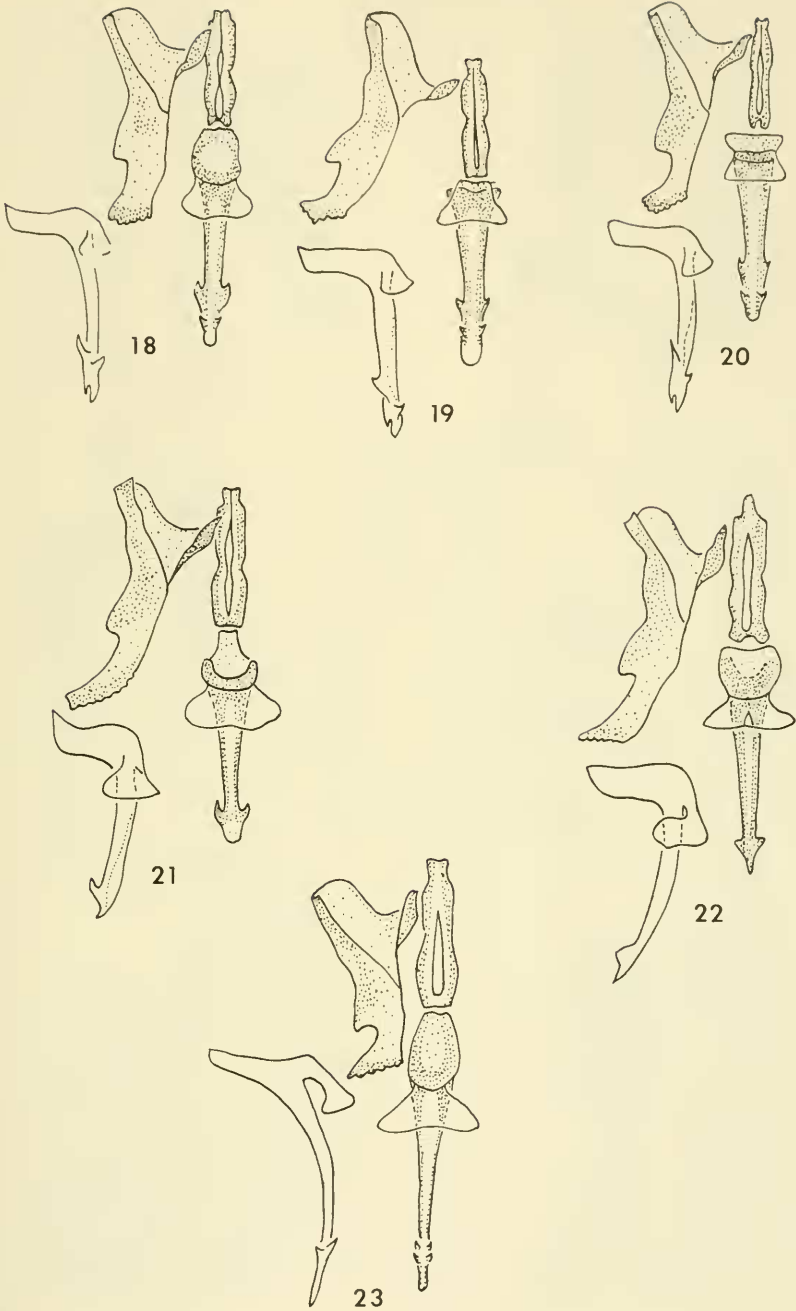
FIGURE 2. Ratio of head width (W) to head length (L) for all species of *Gipsus*.



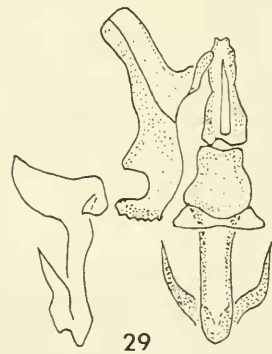
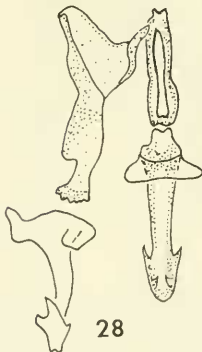
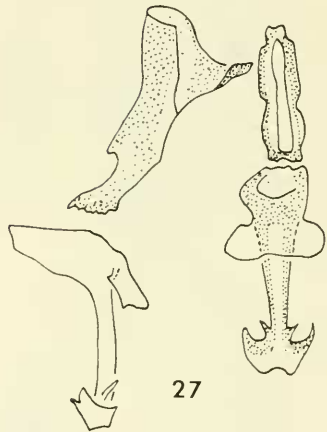
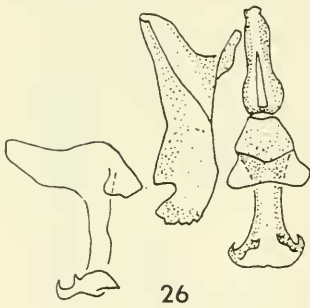
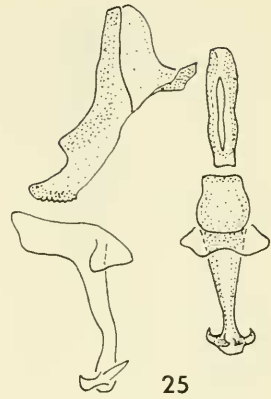
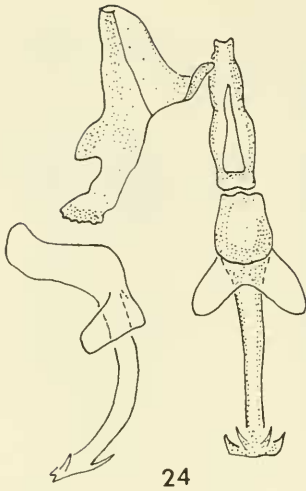
FIGURES 3-8. FIGURE 3. *Giprus siskiyou*: forewing; FIGURE 4. *G. agrestis*: fifth instar nymph; FIGURE 5. *G. siskiyou*: head; FIGURE 6. *G. cajon*: female 7th sternum; FIGURE 7. *G. agrestis*: female 7th sternum; FIGURE 8: *G. joaquinus*: female 7th sternum.



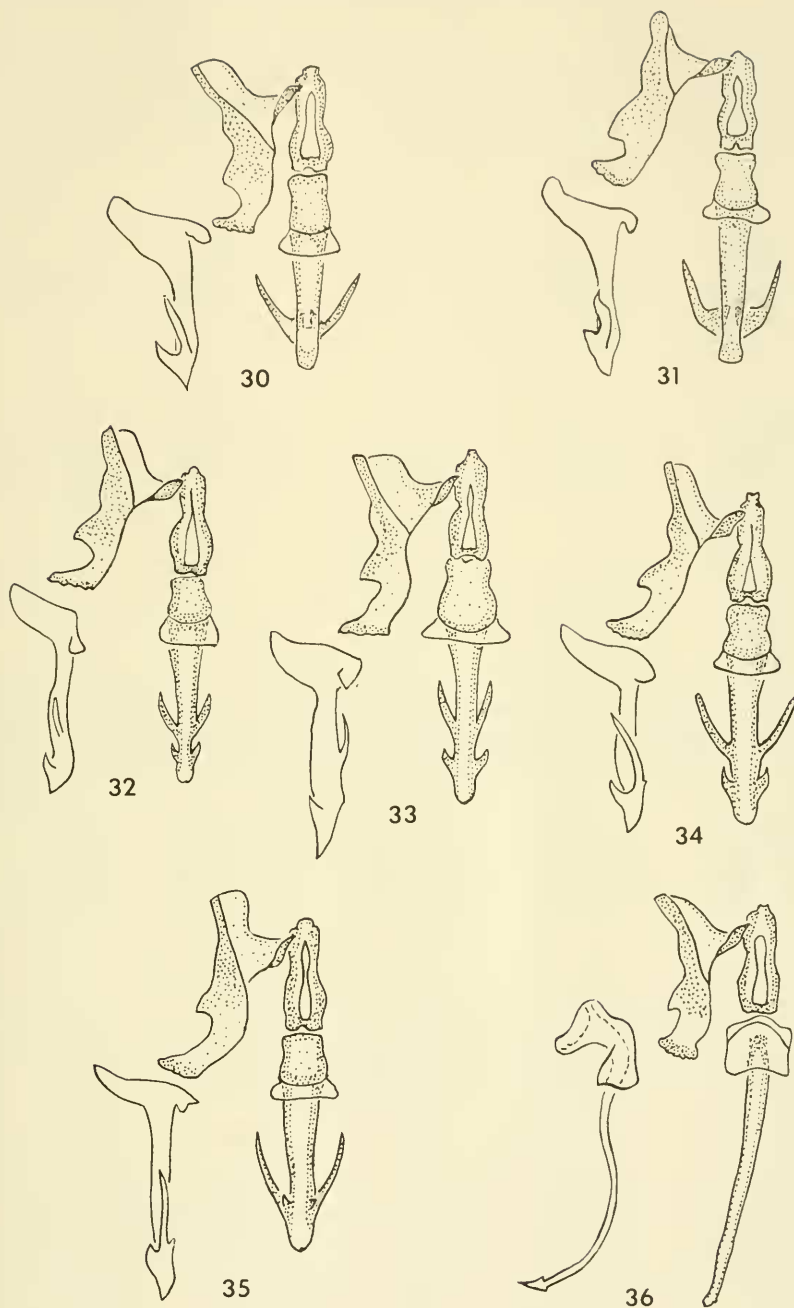
FIGURES 9-17. FIGURE 9. *Giprus cartwrighti*: female 7th sternum; FIGURE 10. *G. siskiyou*: male genital segments; FIGURE 11. *G. desertorum*: male genital segments; FIGURE 12. *G. arenarius*: male genital segments; FIGURE 13. *G. cartwrighti*: male genital segments; FIGURE 14. *G. cinerosus*: connective and aedeagus; FIGURE 15. *Laevicephalus sylvestris* (Osborn & Ball): connective and aedeagus; FIGURE 16. *Laevicephalus incongruus*: connective, style, and aedeagus; FIGURE 17. *G. siskiyou* (Mt. Shasta, California): connective, style, and aedeagus.



FIGURES 18-23. Connective, style, and aedeagus of:
FIGURE 18. *Giprus siskiyou* (24 km. NE. Alturas, California);
FIGURE 19. *G. siskiyou* (Cliffdell, Washington); FIGURE 20.
G. siskiyou (18 km. E. Frenchglen, Oregon); FIGURE 21. *G.*
bidentatus; FIGURE 22. *G. arenarius*; FIGURE 23. *G. joa-*
quinus.



FIGURES 24-29. Connective, style, and aedeagus of:
FIGURE 24. *Giprus decurvatus*; FIGURE 25. *G. angelus*;
FIGURE 26. *G. crassus*; FIGURE 27. *G. orarius*; FIGURE 28.
G. agrestis; FIGURE 29. *G. vastitatus*.



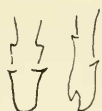
FIGURES 30-36. Connective, style, and aedeagus of:
FIGURE 30. *Giprus californicus* (Tehachapi Pass, California);
FIGURE 31. *G. californicus* (Mill Valley, California);
FIGURE 32. *G. pacificus*; FIGURE 33. *G. cajon*; FIGURE 34.
G. desertorum; FIGURE 35. *G. cinerosus*; FIGURE 36. *G. cartwrighti*.



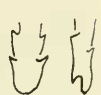
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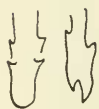
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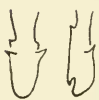
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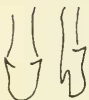
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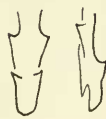
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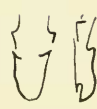
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← FIGURES 37-72. FIGURES 37-53. *Giprus siskiyou* (5 km. S. Weed, California): apex of aedeagus; FIGURES 54-72. *G. siskiyou* (58 km. E. Klamath Falls, Oregon): apex of aedeagus.